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ABSTRACT

This study explored: (1) the opinions of secondary and postsecondary faculty on what ought to be included in the secondary geometry curriculum to prepare students for selected postsecondary courses, (2) the effect of feedback of participants' responses, and (3) the reasons given by the participants to support their judgments. The original sample consisted of 426 secondary and postsecondary faculty members. The results of the study, after two rounds of questionnaires, indicated that some major differences exist between secondary and postsecondary faculty on what ought to be included in the secondary geometry curriculum and on the justifications used to support their judgments. (Author/DT)

AGREEMENT BY SECONDARY AND POSTSECONDARY FACULTY ON THE CONTENT OF HIGH SCHOOL GEOMETRY

by

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Background and Purpose

Although curriculum content selection is a difficult problem in itself, it is compounded by other problems such as the problems of articulation between levels of schooling. Traditionally, many curricular decisions are justified on the basis of what a student will need at or what will be expected by the next higher educational level. Assuming that the teachers directly responsible for implementing the curriculum will, when they make choices among content, choose that content which seems to be the most reasonable for whatever comes thereafter for the student, it becomes very important in efforts to improve the articulation among levels of schooling to know the beliefs of teachers as to what ought and ought not to be included in the curriculum.

Thus this paper reports our efforts to estimate the beliefs of secondary and postsecondary teachers about the content of high school geometry. Recent developments in geometry and the current debate as to the content and methodology of high school geometry made it a promising topic of study. Specifically we sought (1) to see if what high school geometry teachers think ought to be taught to prepare students for postsecondary schooling (college, university, and occupatioanl/technical schools) agrees with what postsecondary faculty think ought to be included in high school geometry to prepare the students for the courses they teach; (2) to see how stable these reported beliefs are when exposed to feedback about the beliefs of other involved groups of teachers; and (3) to compare the justifications used for including or excluding content.

Population

The intended sample - all from Onondaga County, New York - included 102 secondary geometry teachers (from 31 schools) and 324 postsecondary faculty (from one university, four colleges, and four technical/ occupational schools) who were identified (in a prestudy) as teaching courses which require their students to have some knowledge of secondary geometry.

Development of the Instrument

A list of fourteen broad topics (roughly equivalent to chapter headings) and 109 subtopics was prepared based on a comparison of the three geometry textbooks used most widely in Onondaga County, New York, (the site of the study); the New York State syllabus for geometry, the syllabi of Syracuse and two suburban school districts, and feedback from a panel of secondary and postsecondary faculty. This list was then used to prepare three forms of the questionnaire. Each form contained all fourteen broad topics on the first page, but they differed thereafter in that each form contained about one-third of the subtopics grouped under their appropriate broad topic headings. Thus we got responses to all fourteen broad topics and 109 subtopics but no one respondent had to respond to more than 38 subtopics.

Procedure for the Study

For the first round of the study. respondents were randomly given one of three forms of the questionnaire. Subjects were asked to check those topics and subtopics which they considered important enough to be included in the high school curriculum. Secondary faculty were asked to respond on the basis of what they thought would help prepare students for various postsecondary institutions: postsecondary, on the basis of what they thought students should know before taking the courses they taught. The questionnaires were coded by school and department or discipline.

Sixty-five secondary teachers (64%) and 99 postsecondary faculty (31%) responded. Unfortunately, not a single teacher from the technical/occupational school agreed to participate in the study.

For the second round, each subject received the same form of the questionnaire as before. However, added to it was (a) a record of that subject's response to each item in the first round, (b) a record of the percentage of positive responses by groups such as secondary geometry teachers, postsecondary mathematics faculty, and postsecondary engineering faculty. (c) an opportunity to change one's previous response, and (d) a request for the reason for one's original response or, in the case the subject chose to change his response, the reason for the change.

There were 93 responses to the second round, 35 secondary teachers (54% of those in round one but only 34% of the intended sample) and 58 postsecondary faculty (59% and 18% respectively). The attrition was such that the intended analysis of responses on the subtopics had to be abandoned in most cases for lack of numbers. This paper only presents the responses to broad topics.

The discussion of the data analyses will use the following abbreviations:

SF = secondary geometry faculty

PF = postsecondary faculty (total)

AR = architecture faculty
MA = mathematics faculty
CH = chemistry faculty
PH = physics faculty
EN = engineering faculty

Findings

Disciplines. There was significant disagreement ($p<.05$, χ^2) among the five postsecondary groups (AR, CH, EN. MA. and PH) on five (36%) of the fourteen broad topics: introduction to coordinate geometry, solid geometry, vectors, non-Euclidean geometry, and transformation. Table 1 summarizes this data.

Insert Table 1 about here.

Institutions: Comparing the responses of the university and colleges revealed that there was less disagreement among institutions than within institutions. On only two broad topics (14%) was there significant disagreement: transformation and loci and construction.

Secondary and Postsecondary: There was a substantial difference of opinion between secondary geometry teachers (SF) and postsecondary faculty(PF) on what ought to be included in high school geometry, with significant differences on ten of the fourteen topics(71%). Only elements of geometry, methods of arriving at conclusions, introduction to coordinate geometry, and loci and construction were not significantly disagreed upon. Although these do indicate significant differences in the proportion of the two groups wanting to include ten of the fourteen topics, it is interesting to note that on only three of the ten was there a reversal of direction--that is, the majority of one group wants to include a topic and a majority of the other wants to exclude it. SF wanted to exclude solid geometry, vectors and non-Euclidean geometry. Table 2 summarizes these proportional responses.

Insert Table 2 about here.

Secondary faculty and postsecondary disciplines: SF and MA differed significantly on their responses to four (29%) broad topics: congruent triangles, introduction to coordinate geometry, vectors, and transformation. Of these differences, however, in only one case did they disagree on direction: SF wanted to exclude transformation while MA did not.

AR, CH, and EN unanimously endorsed solid geometry, which SF would delete. Vectors drew almost no support from SF (6%) but was supported by AR, CH, EN and PH. Only AR wanted to include non-Euclidean geometry, although a signigicantly larger proportion of EN favored it than SF. AR, CH, EN, and MA differed significantly in the proportion of their responses to transformation when compared with SF, but of the four, only EN (55%) agreed with SF in rejecting it.

Feedback: The feedback of the responses of other participants did not produce any discernible pattern of change in the response to the second round questionnaires. About half the subjects (50) made changes, but taking together the fourteen broad topics and the approximately 36 subtopics on each of the forms, the average number of changes was still only 3.5. The most stable topic was areas of plane regions, in response to which no one changed his round one choice. Solid geometry was least stable, but only five percent (5%) changed in that case.

Strength of agreement: The absolute difference between the percentage who favored inclusion of a topic and the percentage who opposed it was taken as a measure of strength of agreement: the larger that number, the stronger the agreement. Clearly the strongest disagreements centered on geometric inequalities; loci and construction, solid geometry; transformation, and vectors with absolute differences of 46,48, 32, 10 and 6 respectively. Table 3 summarizes these responses.

Insert Table 3 about here

Justifications: SF tended to write reasons for making or changing a response more often than PF, and SF tended to rely on categories of justifications other than those used by PF. In giving reasons for including topics, SF made comments about the logical development of subject matter, the organization of subject matter, the valuableness of human experience, pedagogical considerations, and relevance. Each of these categories was used significantly more by SF than PF ($p<.05, \chi^2$). When justifying exclusions, SF used intelligibility of the subject matter and time factors significantly more, and PF used organization of subject matter significantly more. There were no significant differences in categories used by SF and PF in justifying changed responses.

Discussion

One must approach such a study as this with caution. The subjects were a self-selected sample of secondary and postsecondary faculty members in a single county. The attrition rate between the two rounds was so high that much of the intended data analysis had to be abandoned. These and other limitations discourage one from doing more than posing questions to be investigated in other research.

Do faculty and other curriculum development groups arrive at curriculum decisions in an explicit and rational manner? What is the relationship between what curriculum groups say should be included in the curriculum when specifically queried and what they actually include in the curriculum?

Do the justifications given represent the rational and true base for making curriculum decisions or are they ceremonial offerings to an inquiring public?

Would efforts directed at decreasing the verbalized disagreement over what ought to be taught and at amalgamating the range of justificatory categories used result in better articulation between secondary and postsecondary programs?

Are secondary teachers typically uninformed about the expectations of postsecondary teachers?

Do college faculty really expect the geometric knowledge in their courses that they say they do?

Would the feedback element be more powerful if reasons were asked for in round one and then were reported as group data in round two?

Table 1

Chi-square Values for the Differences in the Decision to Include the Broad Topics Among Disciplines, Institutions, and Educational Levels

Broad Topics	AR,CH,EN, PH,MA (df=4)	LM+MR,SUNY, SU,OCC (df=3)	SF,PF (df=1)	SF,MA (df=1)	SF,AR (df=1)	SF,CH (df=1)	SF,EN (df=1)	SF,PH (df=1)
Elements of geometry (definition of basic terms)	3.13	1.54	.06	.12	.03	.03	.33	.01
Methods of arriving at conclusions (deduction, induction, etc.)	2.37	1.80	.06	.12	.03	.05	.26	.03
Congruent triangles	6.65	5.89	13.94*	6.37*	.03	.05	.02	.03
Geometric inequalities	4.35	7.09	4.59*	.92	.04	3.05	.01#	.31
Parallelism	8.19	4.53	10.83*	2.06	.03	.05	.33	.03
Geometric proportions and similarity	4.62	2.39	5.27*	.02	.03	.03	.02	.03
Circles (arcs, chords, sectors, tangent lines, etc.)	2.38	3.06	7.74*	.02	.03	.03	.02	.03
Introduction to coordinate geometry (slope of line, graphing, etc.)	11.87*	.96	2.70	6.38*	.03	.03	.02	.03
Loci and construction	8.41	7.82*	3.54	.92	.01#	3.05	.29	.01#
Areas of plane regions (triangles, quadrilaterals, etc.)	1.32	3.12	6.[illegible]9*	.02	.03	.03	.02	.03
Solid geometry (definition, area and volume of solids, etc.)	18.86*	.69	28.19*	1.42	9.37*	10.37*	20.26*	3.72
Vectors (vector operations, use of vectors in proving theorems, etc.)	11.93*	1.61	69.28*	14.94*	23.36*	46.05*	41.59*	29.88*
Non-Euclidean geometry (development of elliptic and hyperbolic geometry)	19.57*	.81	7.66*	.54	20.61*	2.03	4.07*	.05
Transformation (translation, reflection, expansion, etc.)	11.83*	11.01*	35.06*	13.63*	21.72*	23.91*	6.78*	2.03

* $p < .05$ # $X^2 < .01$

[a] SF=secondary faculty; PF=postsecondary faculty; AR=architecture faculty; CH=chemistry faculty; EN=engineering faculty; MA=mathematics faculty; PH=physics faculty; LM=LeMoyne College faculty; MR=Maria Regina faculty; OCC=Onondaga Community College faculty; SUNY=College of Forestry and Environmental Science faculty; SU=Syracuse University faculty.

Table 2

Proportion of Respondents Choosing to Include Broad Geometry Topics in the Curriculum Broken Down by Educational Levels, Disciplines, and Institutions

Broad Topic	SF (65)	PF (99)	AR (10)	CH (11)	EN (22)	MA (20)	PH (10)	LM&MR (11)	OCC (9)	SUNY (14)	SU (61)[a]
1. Elements of geometry (definition of basic terms)	.95	.95	1	1	.95	.90	1	1	.89	.93	.97
2. Methods of arriving at conclusions (deduction, induction, etc.)	.94	.96	.90	.91	1	.95	.90	1	.89	1	.95
3. Congruent triangles	.98	.76	.80	.55	.91	.80	.90	.55	.56	.71	.82
4. Geometric inequalities	.83	.67	.80	.55	.86	.70	.70	.73	.44	.43	.74
5. Parallelism	.97	.77	.90	.55	.91	.85	.90	.55	.67	.71	.82
6. Geometric proportions and similarity	.98	.88	1	.82	.95	.95	1	.91	1	.79	.87
7. Circles (arcs, chords, sectors, tangent lines, etc.)	.97	.81	.90	.82	.95	.90	.80	.73	.67	.71	.85
8. Introduction to coordinate geometry (slope of line, graphing, etc.)	.98	.91	.70	1	1	.80	1	.91	.89	.86	.93

[a]Number in parenthesis = n.

Table 2 --Continued

Broad Topic	SF (65)	PF (99)	AR (10)	CH (11)	EN (22)	MA (20)	PH (10)	LM&MR (11)	OCC (9)	SUNY (14)	SU (61)[a]
9. Loci and construction	.83	.69	.90	.55	.91	.70	.90	.45	.44	.57	.77
10. Areas of plane regions (triangles, quadrilaterals, etc.)	.98	.85	.90	.91	.95	.85	.90	.91	.67	.79	.87
11. Solid geometry (definition, area and volume of solids, etc.)	.42	.83	1	1	1	.60	.80	.91	.78	.86	.84
12. Vectors (vector operations, use of vectors in proving theorems, etc.)	.06	.74	.70	1	.77	.45	.80	.64	.67	.71	.79
13. Non-Euclidean geometry (development of elliptic and hyperbolic geometry)	.08	.26	.70	.27	.27	0	.10	.27	.22	.36	.25
14. Transformation (translation, reflection, expansion, etc.)	.15	.64	.90	.91	.45	.60	.40	.73	.22	.50	.74

[a] Number in parenthesis = n.

TABLE 3

Percentages of Respondents Choosing to Exclude or Include Broad Topics in the Geometry Curriculum

Broad Topics (n=164)	Include	Exclude	Absolute Difference
Elements of geometry (definition of basic terms)	95	5	90
Methods of arriving at conclusions (deduction, induction, etc.)	95	5	90
Congruent triangles	85	15	70
Geometric inequalities	73	27	46
Parallelism	85	15	70
Geometric proportions and similarity	92	8	84
Circles (arcs, chords, sectors, tangent lines, etc.)	87	13	74
Introduction to coordinate geometry (slope of line, graphing, etc.)	94	6	88
Loci and construction	74	26	48
Areas of plane regions (triangles, quadrilaterals, etc.)	90	10	80
Solid geometry (definition, area and volume of solids, etc.)	66	34	32
Vectors (vector operations, use of vectors in proving theorems, etc.)	47	53	6
Non-Euclidean geometry (development of elliptic and hyperbolic geometry)	19	81	62
Transformation (translation, reflection, expansion, etc.)	45	55	10